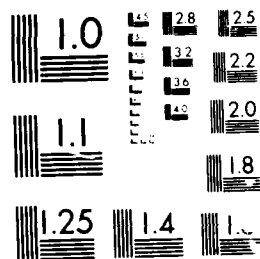


AD-A191 385 REPAIR WORKS FOR UPLIFT AND SEEPAGE CONTROL IN EXISTING 1/1
CONCRETE DAMS(U) LABORATORIO NACIONAL DE ENGENHARIA
CIVIL LISBON (PORTUGAL) J O PEDRO OCT 87
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REPAIR WORKS FOR UPLIFT AND SEEPAGE CONTROL
IN EXISTING CONCRETE DAMS

by

José Cliveira Pedro

United States Army
RESEARCH, DEVELOPMENT & STANDARDIZATION GROUP U.K.
CONTRACT NUMBER DAJA45 - 87 -.C - 0022
First Interim Report

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This report is intended only for the internal management use of the Contractor and the U.S. Government.

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LABORATORIO NACIONAL DE ENGENHARIA CIVIL, LNEC

Lisbon, October, 1987

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1 - The present research project aims at the study of the deteriorations of foundations of concrete dams. Three main steps are envisaged in the development of the work: i) analysis of case histories on the deterioration of foundations of some Portuguese arch dams and on the behaviour of some Portuguese gravity dam foundations; ii) study of the hydromechanical behaviour using mathematical and experimental methods; and iii) studies on the materials and techniques used for the repair works in concrete dam foundation.

2 - Following the approval of the contract last June, Mr. Luis Ribeiro e Sousa, an associate investigador attached to this project, visited the U.S. Army Waterways Experimental Station - WES (Vicksburg, USA) in the second week of September. The report of this visit is appended (Appendix A).

After the contacts of Mr. Ribeiro e Sousa with the technical staff of WES it was understood that this visit would be considered as the first interim report - item n6 0001 of the contract.

3 - Besides the information included in the report of the visit, additional information is included on the planning of the work. The work should be divided into four technical reports, which will be included in the final report. Draft lists of the items to be developed in each report as well as a general plan for the activities are also appended (Appendix B).

Appendix A

Visit to the Waterways Experimental Station

Vicksburg, Mississippi

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VISIT TO THE WATERWAYS EXPERIMENTAL STATION,
VICKSBURG, MISSISSIPPI

by

Luis Ribeiro e Sousa

1 - INTRODUCTION

Following the approval of the research project "Repair Works for Uplift and Seepage Control in Existing Concrete Dams", under contract DAJA45-87-C-0022, between the U.S. Army European Research Office (ERO) and Laboratório Nacional de Engenharia Civil (LNEC), a visit was organized for one of the associate investigators involved in this project, for the main purposes of establishing contacts with researchers of the U.S. Army Waterways Experimental Station - WES, in Vicksburg (USA) and there discussing problems of mutual concern relating to studies to be carried out by LNEC in the scope of the contract.

The visit took place from 8 - 14 September, 1987, in accordance with the schedule set up by Dr. Don Banks, head of the Engineering Geology and Rock Mechanics Division of the Geotechnical Laboratory.

2 - VISIT TO THE ENGINEERING GEOLOGY AND ROCK MECHANICS DIVISION

Most of the visit took place in the Engineering Geology and Rock Mechanics Division. After the first contact with Dr. Don Banks, the signatory had the opportunity of informal and direct exchanges of views with the technical staff of the Rock Mechanics

Applications Group, directed by Dr. Jerry Huie.

The following research areas were dealt with in the course of talks:

- Analyses of water seepage in rock masses;
- Stability of underground structures and use of anchorings;
- Constitutive models in fractured media based on the use of empirical methodologies;
- Storage of low- radioactivity nuclear waste;
- Grouting techniques and materials for rock masses;
- Problems of lock foundations, namely the St. Lawrence Seaway.

In the course of the visit, the signatory made an oral expose, complemented by slides, on the LNEC's activity in the domain of the foundations of concrete dams and associated works such as underground power plants. In connection with the research project, an analysis was made of case histories on deterioration of rock mass foundations, namely of some Portuguese dams, particular emphasis being laid upon Várzea, Bouçã and Venda Nova dams, the first two being arch dams and the third an arch-gravity dam. Portuguese experience in the domain of gravity dams was illustrated, special attention being paid to the cases of Alto Rabagão, Raiva, Torrão and of the dams in the river Douro. Mention was also made of the relevant experience acquired by LNEC as a result of its activity in the schemes of Aguieira (Portugal), Cahora-Bassa (Mozambique) and Alto Lindoso (Portugal).

The scope and planning of studies to be carried out within the research project were discussed, the themes to be dealt with

being:

- 1 - Study of the hydraulic and mechanical behaviour predicted and observed, and on grouting and drainage works, using mathematical and experimental methods;
- 2 - Studies on the materials and techniques used in the construction of repair works.

The comments made will be considered in the next progress report to be prepared by LNEC. Dr. David Bennett was appointed the liaison officer between WES and LNEC for this project.

3 - OTHER TECHNICAL VISITS

A visit to the Structures Laboratory should also be reported, which was conducted by Dr. William McCleese, manager of the programme 'REMR - Repair, Evaluation, Maintenance and Rehabilitation Research'.

That Laboratory carries out research projects in the following fields:

- Repair, maintenance and rehabilitation of structures;
- Technology of concretes and composite materials;
- Structural behaviour;
- Dynamic structural analysis;
- Simulation studies of explosions.

Of note is also a visit to the Soil Mechanics Division of the Geotechnical Laboratory. This Division is provided with sophisticated equipment for laboratory tests, making it possible to perform complex studies on the mechanical and hydraulic behaviours of earthfills.

4 - CONCLUSION

Upon an overall assessment of the technical aspects involved, direct contact with this important research institution was considered of much interest, since it enabled the signatory to gather fairly detailed and updated technical information in WES research fields, particularly those related to the research project in development.

Appendix B
Lists of items to be developed
in the technical reports
and
Plan of activities

Report R1 - ROCK MASS FOUNDATION DETERIORATIONS OF SOME
PORTUGUESE ARCH DAMS. CASE HISTORIES

1. Introduction

(Aim and scope of paper; selected examples; criteria)

2. Varosa dam

2.1 General

(Description of the works; main features of the design
and construction)

2.2 Monitoring

(Plan of observation; first filling of the reservoir;
detection of the abnormal behaviour)

2.3 Model analysis

(Structural and hydraulic models; analysis of utilization
and hazard scenarios)

2.4 Repair works

(Description and justification of the selected solutions)

2.5 Behaviour after repair

(Description of structural and hydraulic behaviour after
the repair works; efficiency of these works)

3. Bouça dam

3.1 General

3.2 Monitoring

3.3 Model analysis

3.4 Repair works

3.5 Behaviour after repair

4. Venda Nova Dam

- 4.1 General
- 4.2 Monitoring
- 4.3 Model analysis
- 4.4 Repair works
- 4.5 Behaviour after repair

Report R2 - HYDROMECHANICAL BEHAVIOUR OF SOME PORTUGUESE CONCRETE
GRAVITY DAM FOUNDATIONS. CASE HISTORIES

1. Introduction

(Aim and scope; selected examples; criteria)

2. Alto Rabagão dam

2.1 General

(Description of the works; main features of the design
and construction)

2.2 Monitoring

(Plan of observation; first filling of the reservoir;
main results of observation, namely of hydromechanical
behaviour)

2.3 Model analysis

(Structural and hydraulic models; comparison of results
observed and predicted by models)

2.4 Conclusion

(Evaluation of the hydromechanical behaviour of dam
foundation; main conclusions)

3. Raiva dam

3.1 General

3.2 Monitoring

3.3 Model analysis

3.4 Conclusion

4. Torrão dam

- 4.1 General
- 4.2 Monitoring
- 4.3 Model analysis
- 4.4 Conclusion

Report R3 - MODELLING OF THE HYDROMECHANICAL BEHAVIOUR
OF CONCRETE DAM FOUNDATIONS

1. Introduction

(Aim and scope; models and methods of analysis of the hydromechanical behaviour of concrete dam foundations; application in the interpretation of results of observation and in the analysis of design solutions of repair works)

2. Models

(Main assumptions on structural properties - geometric, physical and chemical - and on actions)

3. Methods of analysis

(Structural, hydraulic and coupled models; finite element approach; boundary element approach)

4. Quantitative interpretation of results observed

(Structural and hydraulic models; deterministic and statistical methods)

5. Examples

5.1 Interpretation of the results of observation

(Torrão hollow gravity dam; Raiva massive gravity dam; Bouçã arch dam)

5.2 Design solutions of repair works

Report R4 - TESTS FOR DETERIORATION EVALUATION AND FOR
ANALYSIS OF REPAIR WORKS IN CONCRETE DAM
FOUNDATIONS

1. Introduction

(Classification of deterioration and detection methods in
concrete dam foundations; repair works)

2. Deteriorations detection methods

2.1 General

(Classification of detection methods; methods of evaluation
- model analysis)

2.2 Monitoring

(Displacements and fissuration; uplift and seepage)

2.3 Field tests

(Permeability; geophysical and hydrochemical methods)

2.4 Laboratory tests

3. Repair works

3.1 General

(Construction conditions, techniques and materials)

3.2 Main solutions for repair works in concrete dam foundations

(Watertightening and drainage works; design criteria)

3.3 Efficiency control of the works.

PLAN OF ACTIVITIES

	87	88	89
	O N D	J F M A M J J A S O N D	J F M A M J
R 1 - Arch dams	Collection and analysis of information	report	
R 2 - Gravity dams	Collection and analysis of information	report	
R 3 - Modelling	Torrão and Bouçã dams Venda Nova dam Alto Rabagão and Raiva dams	report	
R 4 - Tests	Geophysical and permeability Tests - Torrão and Bouçã dams hydrochemical tests laboratory tests on resins	report	
Final Report			report

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